6.1 Engineered Safety Features Materials

This section provides a description of the materials used in the fabrication of engineered safety features components and of the provisions to avoid material interactions that could potentially impair the operation of the engineered safety features. A list of engineered safety features was given previously in Section 6.0. Reactor coolant system materials, including branch piping connected to the reactor coolant system, are described in subsection 5.2.3.

6.1.1 Metallic Materials

Materials for use in engineered safety features are selected for their compatibility with the reactor coolant system and refueling water.

The edition and addenda of the ASME Code applied in the design and manufacture of each component are the edition and addenda established by the requirements of the Design Certification. The use of editions and addenda issued subsequent to the Design Certification is permitted or required based on the provisions in the Design Certification. The baseline used for the evaluations done to support this safety analysis report and the Design Certification is the 1998 Edition, through the 2000 Addenda. When material is procured to later editions or addenda, the design of the component is reconciled to the new material properties in accordance with the rules of the ASME Code, provided that the later edition and addenda are authorized in 10 CFR 50.55a or in a specific authorization as provided in 50.55a(a)(3).

6.1.1.1 Specifications for Principal Pressure-Retaining Materials

The pressure-retaining materials in engineered safety features system components comply with the corresponding material specification permitted by the ASME Code, Section III, Division 1. The material specifications used for pressure-retaining valves in contact with reactor coolant are the specifications used for reactor coolant pressure boundary valves and piping. See Table 5.2-1 for a listing of these specifications. The material specifications for pressure-retaining materials in each component of an engineered safety features system meet the requirements of Article NC-2000 of the ASME Code, Section III, Class 2, for Quality Group B; Article ND-2000 of the ASME Code, Section III, Class 3, for Quality Group C components; and Article NE-2000 of the ASME Code, Section III for containment pressure boundary components.

Containment penetration materials meet the requirements of Articles NC-2000 or NE-2000 of the ASME Code, Section III, Division 1. The quality groups assigned to each component are given in Section 3.2. The pressure-retaining materials are indicated in Table 6.1-1. Materials for ASME Class 1 equipment are provided in subsection 5.2.3.

The following subsection provides information on the selection and fabrication of the materials in the engineered safety features of the plant.

Components in contact with borated water are fabricated of, or clad with, austenitic stainless steel or equivalent corrosion-resistant material. The use of nickel-chromium-iron alloy in the engineered safety features is limited to Alloy 690 or its associated weld metals Alloys 52 and 152. Nickel-chromium-iron alloy is used where the corrosion resistance of the alloy is an important consideration and where the use of nickel-chromium-iron alloy is the choice because of the coefficient of thermal expansion.

The material for the air storage tanks in the main control room emergency habitability system is tested for Charpy V-Notch per supplement S3 of material specification SA-372 and has an average of 20 to 25 mills of lateral expansion at the lowest anticipated service temperature. The material is not permitted to be weld repaired.

6.1.1.2 Fabrication Requirements

The welding materials used for joining the ferritic base materials of the pressure-retaining portions of the engineered safety features conform to, or are equivalent to, ASME Material Specifications SFA 5.1, 5.5, 5.17, 5.18, 5.20, 5.23, 5.28, 5.29, and 5.30. The welding materials used for joining nickel-chromium-iron alloy in similar base material combination, and in dissimilar ferritic or austenitic base material combination, conform to ASME Material Specifications SFA 5.11 and 5.14, or are similar welding alloys to those in SFA-5.11 or SFA-5.14 developed for improved weldability as allowed by the ASME Boiler and Pressure Vessel Code rules.

The welding materials used for joining the austenitic stainless steel base materials for the pressure-retaining portions of engineered safety features conform to, or are equivalent to, ASME Material Specifications SFA 5.4, 5.9, 5.22, and 5.30. These materials are qualified to the requirements of the ASME Code, Section III and Section IX, and are used in procedures qualified to these same rules. The methods used to control delta ferrite content in austenitic stainless steel weldments in engineered safety features components are the same as those for ASME Code Class 1 components, described in subsection 5.2.3.4.

The integrity of the safety-related components of the engineered safety features is maintained during component manufacture. Austenitic stainless steel is used in the final heat-treated condition as required by the respective ASME Code, Section II, material specification for the particular type or grade of alloy. Also, austenitic stainless steel materials used in the engineered safety features components are handled, protected, stored, and cleaned according to recognized and accepted methods designed to minimize contamination, which could lead to stress corrosion cracking. These controls for engineered safety features components are the same as those for ASME Code Class 1 components, discussed in subsection 5.2.3.4. Sensitization avoidance, intergranular attack prevention, and control of cold work for engineered safety features components are the same as the ASME Code Class 1 components discussed in subsection 5.2.3.4. Cold-worked austenitic stainless steels having a minimum specified yield strength greater than 90,000 psi are not used for components of the engineered safety features.

Information is provided in Section 1.9 concerning the degree of conformance with the following Regulatory Guides:

- Regulatory Guide 1.31, Control of Ferrite Content in Stainless Steel Weld Metal
- Regulatory Guide 1.44, Control of the Use of Sensitized Stainless Steel

Lead, antimony, cadmium, indium, mercury, and tin metals and their alloys are not allowed to come in contact with engineered safety features component parts made of stainless steel or high alloy metals during fabrication or operation. Bearing alloys containing greater than 1 percent of lead, antimony, cadmium, or indium are not used in contact with reactor coolant.

6.1.1.3 Specifications for Nonpressure-Retaining Materials

Materials for nonpressure-retaining portions of engineered safety features in contact with borated water or other fluids may be procured under ASTM designation. The principle examples of these items are the in-containment refueling water storage tank liner and the passive containment cooling system storage tank liner.

The walls of the in-containment refueling water storage tank are fabricated of ASTM/ASME A240/SA-240, UNS S32101. This is a chromium, manganese, and nitrogen-strengthened duplex stainless steel with higher ultimate tensile and yield strengths than type 304 and 316 stainless steel. This material can be welded using a matching Duplex 2101 (2304 or 2209) filler metal by any of the commonly used stainless steel welding methods, including shielded metal arc welding (SMAW), gas tungsten arc welding TIG (GTAW), gas metal arc welding MIG (GMAW), flux-cored arc welding (FCW), plasma arc welding (PAW), and submerged arc welding (SAW). This material is used for applications where the higher strength allows reductions in weight and material costs. The material has a resistance to intergranular stress corrosion cracking similar to or better than type 304 and 304L stainless steel.

6.1.1.4 Material Compatibility with Reactor Coolant System Coolant and Engineered Safety Features Fluids

Engineered safety features components materials are manufactured primarily of stainless steel or other corrosion-resistant material. Protective coatings are applied on carbon steel structures and equipment located inside the containment, as discussed in subsection 6.1.2.

Austenitic stainless steel plate conforms to ASME SA-240. Austenitic stainless steel is confined to those areas or components which are not subject to post-weld heat treatment. Carbon steel forgings conform to ASME SA-350. Austenitic stainless steel forgings conform to ASME SA-182. Nickel-chromium-iron alloy pipe conforms to ASME SB-167. Carbon steel castings conform to ASME SA-352. Austenitic stainless steel castings conform to ASME SA-351.

Hardfacing material in contact with reactor coolant is a qualified low- or zero-cobalt alloy, equivalent to Stellite-6. The use of cobalt-base alloys is minimized. Low- or zero-cobalt alloys used for hardfacing or other applications where cobalt-base alloys have been previously used are qualified by wear and corrosion tests. The corrosion tests qualify the corrosion resistance of the alloy in reactor coolant. Cobalt-free, wear-resistant alloys considered for this application include those developed and qualified in nuclear industry programs.

In post-accident situations where the containment is flooded with water containing boric acid, pH adjustment is provided by the release of trisodium phosphate into the water. The trisodium phosphate is held in baskets located in the floodable volume that includes the steam generator compartments and contains the reactor coolant loop. The addition of trisodium phosphate to the solution is sufficient to raise the pH of the fluid to above 7.0. This pH is consistent with the guidance of NRC Branch Technical Position MTEB-6.1 for the protection of austenitic stainless steel from chloride-induced stress corrosion cracking. Section 6.3 describes the design of the trisodium phosphate baskets.

In the post-accident environment, both aluminum and zinc surfaces in the containment are subject to chemical attack resulting in the production of hydrogen and/or chemical precipitants that can affect long-term core cooling. The amount of aluminum allowed in the containment below the maximum flood level of a design basis loss-of-coolant accident (LOCA) (refer to subsection 6.3.2.2.7.1, item 3) will be limited to less than 60 pounds during operating conditions. A large potential source of aluminum in the AP1000 containment are the excore detectors described in subsection 7.1.2.7.2. To avoid sump water contact with the excore detectors, they are enclosed in stainless steel or titanium housings. The non-flooded surfaces would be wetted by condensing steam, but they would not be subjected to the boric acid or trisodium phosphate solutions since there is no containment spray. For this reason, the amount of aluminum in the excore detectors is not applied to the 60-pound weight limit restriction as they are not subject to the post-design basis accident (DBA) environment as a result of steel/titanium encasement. Furthermore, other aluminum, within containment encased in stainless steel/titanium that can ensure interaction with the boric acid or trisodium phosphate solutions does not occur, should not be applied to the 60-pound weight limit. Nonsafety-related passive autocatalytic recombiners are provided to limit hydrogen buildup inside containment.

6.1.1.5 Integrity of Safety-Related Components

The pH adjustment baskets provide for long-term pH control. In the case of inadvertent short-term flooding when the pH adjustment baskets remain above the flood level, the condition of the material in contact with the fluid is evaluated prior to return to operation. Based on previous industry testing and experience, the behavior of austenitic stainless steels in the post-design basis accident environment is acceptable. Cracking is not anticipated, provided that the core cooling pH is maintained at an adequate level.

6.1.1.6 Thermal Insulation

The majority of the engineered safety features insulation used in the AP1000 containment is reflective metallic insulation. Fibrous insulation may be used if it is enclosed in stainless steel cans. The selection, procurement, testing, storage, and installation of nonmetallic thermal insulation provides confidence that the leachable concentrations of chloride, fluoride, and silicate are in conformance with Regulatory Guide 1.36. Conformance with Regulatory Guide 1.36 is summarized in Section 1.9.

6.1.1.7 Component and System Cleaning

See subsection 1.9.1 for a discussion on the provisions of Regulatory Guide 1.37 for the cleaning of components and systems.

6.1.2 Organic Materials

6.1.2.1 Protective Coatings

6.1.2.1.1 General

The AP1000 is divided into four areas with respect to the use of protective coatings. These four areas are:

- Inside containment
- Exterior surfaces of the containment vessel
- Radiologically controlled areas outside containment
- Remainder of plant

The considerations for protective coatings differ for these four areas and the coatings selection process accounts for these differing considerations. The AP1000 design considers the function of the coatings, their potential failure modes, and their requirements for maintenance. Table 6.1-2 lists different areas and surfaces inside containment and on the containment shell that have coatings, their functions, and to what extent their coatings are related to plant safety.

Coatings used outside containment do not provide functions related to plant safety except for the coating on the outside of the containment shell. The coating on the outside of the containment shell above elevation 135′3″ shell supports passive containment cooling system heat transfer and is classified as a Service Level III coating.

The coating used on the inside surface of the containment shell, greater than 7′ above the operating deck, supports the transfer of thermal energy from the post-accident atmosphere inside containment to the containment shell. Passive containment cooling system testing and analysis have been performed with a coating. This coating is classified as a Service Level I coating.

Coatings are not used in the vicinity of the containment recirculation screens to minimize the possibility of debris clogging the screens. Subsection 6.3.2.2.7.3 defines the area in the vicinity of the recirculation screens where coatings are not used.

Coatings used inside containment, except for inorganic zinc used on the inside surface of the containment shell, and on other components, are classified as Service Level II coatings because their failure does not prevent functioning of the engineered safety features. If the Service Level II coatings delaminate, the solid debris they may form will not have a negative impact on the performance of safety-related post-accident cooling systems. See subsection 6.1.2.1.5 for a discussion of the factors including plant design features and low water flows that permit the use of Service Level II coatings inside containment. Protective coatings are maintained to provide corrosion protection for the containment pressure boundary and for other system components inside containment.

The corrosion protection of the containment shell is a safety-related function. Good housekeeping and decontamination functions of the coatings are nonsafety-related functions.

For information on coating design features, quality assurance, material and application requirements, and performance monitoring requirements, see subsection 6.1.2.1.6.

6.1.2.1.2 Inside Containment

Carbon Steel

Inorganic zinc is the basic coating applied to the containment vessel. Below the operating floor, most of the inorganic zinc coating is top coated with epoxy where enhanced decontamination is desired. The epoxy top coat on the containment vessel extends above the operating floor up to a wainscot height of 7 feet above the operating floor. Carbon steel and structural modules within the containment are coated with self-priming high solids epoxy (SPHSE). Where practical, miscellaneous carbon steel items (such as stairs, ceilings, gratings, ladders, railings, conduit, duct, and cable tray) are hot-dip galvanized. Steel surfaces subject to immersion during normal plant operation (such as sumps and gutters) are stainless steel or are coated with SPHSE applied directly to the carbon steel without an inorganic zinc primer. Carbon steel structures and equipment are assembled in modules, and the modules are coated in the fabrication shop under controlled conditions.

Concrete

Concrete surfaces inside containment are coated primarily to prevent concrete from dusting, to protect it from chemical attack, and to enhance decontaminability. In keeping with ALARA goals, the exposed concrete surfaces are made as decontaminable as practical in areas of frequent personnel access and areas subject to liquid spray, splash, spillage, or immersion.

Exposed concrete surfaces inside containment are coated with an epoxy sealer to help bind the concrete surface together and reduce dust that can become contaminated and airborne. Concrete floors inside containment are coated with a self-leveling epoxy or SPHSE floor coating. Exposed concrete walls inside containment are coated to a minimum height of 7 feet with an epoxy or SPHSE applied over an epoxy surfacer that has been struck flush.

6.1.2.1.3 Exterior of Containment Vessel

The exterior of the containment vessel is coated with the same inorganic zinc as is used inside of the containment vessel. The inorganic zinc coating enhances heat transfer by providing good heat conduction and by enhancing surface wetting of the exterior surface of the containment vessel. The inorganic zinc also provides corrosion protection.

6.1.2.1.4 Radiologically Controlled Areas Outside Containment and Remainder of Plant

The coatings used in the radiologically controlled areas outside containment and in the remainder of the plant are also classified as Service Level II coatings. However, these coatings are selected, specified, and applied in a manner that optimizes performance and standardization within the AP1000 design. Therefore, wherever practical, the same coating systems are used in radiologically controlled areas outside containment as are used inside containment. The ALARA concept is carried through in areas subject to radiation exposure and possible radiological contamination.

The remainder of the plant coating systems are commercial grade materials that are selected and applied according to the expected conditions in the specific areas where the coatings are applied.

The coatings used in radiologically controlled areas outside of containment are identified in the following.

Carbon Steel Surfaces

Carbon steel is coated with either SPHSE or an inorganic zinc coating with an epoxy top coat over the inorganic zinc. An epoxy top coat is used in areas subject to decontamination such as a 7 foot wainscot in high traffic areas or on surfaces subject to radiologically contaminated liquid spray, splash, or spills.

Concrete Floors

Floors subject to heavy traffic or contaminated liquid spills are coated with self-leveling epoxy or SPHSE floor coating. An epoxy or SPHSE coat is applied a minimum of 1 foot up the wall where liquid spills might splash. Floors subject to light traffic and not subject to contaminated liquid spills are coated with an epoxy or SPHSE coat. The epoxies applied to the concrete surfaces are the same epoxies used as a top coat for the inorganic zinc-coated steel or SPHSE.

Concrete Walls

A 7-foot wainscot on exposed concrete walls in high-traffic areas and any surfaces of walls subject to spray, splash, or spills of contaminated liquids are coated with an epoxy coat or SPHSE applied over an epoxy surfacer that has been struck flush. The epoxies used on concrete surfaces are the same as that used as a top coat for the inorganic zinc-coated steel or SPHSE. Remaining concrete walls are coated with an epoxy sealer to reduce or eliminate dusting.

Concrete Ceilings

Exposed concrete ceilings are coated with an epoxy sealer to reduce dusting.

6.1.2.1.5 Safety Evaluation

This subsection describes the basis for classifying coatings as Service Level I, II, or III. Table 6.1-2 identifies which coatings are classified as Service Level I and Service Level III.

The inorganic zinc coating on the outside of the containment shell above elevation 135′3′ supports passive containment cooling system heat transfer and is classified as a Service Level III coating.

The inorganic zinc coating used on the inside surface of the containment shell, greater than 7′ above the operating deck, supports the transfer of thermal energy from the post-accident atmosphere inside containment to the containment shell. Passive containment cooling system testing and analysis have been performed with an inorganic zinc coating. This coating is classified as Service Level I coating.

The AP1000 has a number of design features that facilitate the use of Service Level II coatings inside containment. These features include a passive safety injection system that provides a long delay time between a LOCA and the time recirculation starts. This time delay provides time for settling of debris. These passive systems also flood the containment to a high level which allows the use of containment recirculation screens that are located well above the floor and are relatively tall. Significant volume is provided for the accumulation of coating debris without affecting screen plugging. These screens are protected by plates located above the screens that extend out in front and to the side of the screens. Coatings are not used under these plates in the vicinity of the screens. The protective plates, together with low recirculation flow, approach velocity and the screen size preclude postulated coating debris above the plates from reaching the screens. Refer to subsection 6.3.2.2.7.3 for additional discussion of these screens, their protective plates and the areas where coatings are prohibited from being used.

The recirculation inlets are screened enclosures located near the northwest and southwest corners of the east steam generator compartment (refer to the figures in subsection 6.3.2.2.7.3). The enclosure bottoms are located above the surrounding floor, which prevent ingress of heavy debris (density $\geq 100\ lb_m/ft^3$). Additionally, the screens are oriented vertically and are protected by large plates located above the screens, further enhancing the capability of the screens to function with debris in the water. The screen mesh size and the surface area of the containment recirculation screens in the AP1000, in conjunction with the large floor area for debris to settle on, can accommodate failure of coatings inside containment during a design basis accident even though the residue of such a failure is unlikely to be transported to the vicinity of the enclosures.

The AP1000 does not have a safety-related containment spray system. The containment spray system provided in the AP1000 is only used for beyond design basis events. This reduces the chance that coatings will peel off surfaces inside containment because the thermal shock of cold spray water on hot surfaces combined with the rapid depressurization following spray initiation are recognized as contributors to coating failure. Parts of the containment below elevation 110′ are flooded and water is recirculated through the passive core cooling system. However, the volume of water moved in this manner is relatively small and the flow velocity is very low.

The coating systems used inside containment also include epoxy and/or self-priming high solids epoxy coatings. These are applied to concrete substrates, as top coats over the inorganic zinc coating, and directly to steel, as noted in subsection 6.1.2.1.2. The failure modes of these systems could include delamination or peeling if the epoxy coatings are not properly applied (References 1, 2, 3). The epoxies applied to concrete and carbon steel surfaces are sufficiently heavy (dry film density greater than $100\ lb/ft^3$) so that transport of small chips with the low water velocity in the AP1000 containment is limited.

Inside containment, there are components coated with various manufacturers' standard coating systems. These coating systems are generally not required to have Class I or III safety classification as delineated in Table 6.1-2; however, those located below the maximum flood level of a design basis LOCA, or where there is sufficient water flow to transport debris, are required to be sufficiently heavy (dry film density greater than or equal to $100\ lb/ft^3$) so that transport of small chips with the low water velocity in the AP1000 containment is limited.

If a coating on walls, structures, or components has a dry film density less than 100 lb/ft^3, then testing and/or analysis must be performed to demonstrate that the debris is not transported to an AP1000 screen or into the core through a flooded break. The testing and/or analysis must be approved by the NRC.

In addition, inorganic zinc should be used only on surfaces that may be exposed to temperatures that are above the limits of epoxy coatings during normal operating conditions; inorganic zinc coatings used in such applications are required to be Safety – Service Level I to prevent detachment during a LOCA since such debris is not likely to settle out.

Requirements related to production of hydrogen as a result of zinc corrosion in design basis accident conditions, including the zinc in paints applied inside containment, were eliminated by the final rule, effective October 16, 2003, amending 10 CFR 50.44, "Standards for Combustible Gas Control System in Light-Water-Cooled Power Reactors."

6.1.2.1.6 Quality Assurance Features

A number of quality assurance features provide confidence that the coating systems inside the containment, on the exterior of the containment vessel and in potentially contaminated areas outside containment will perform as intended. These features enhance the ALARA program and enhance corrosion resistance. The features are discussed in the following paragraphs.

Service Level I and Service Level III Coatings

The quality assurance program for Service Level I and Service Level III coatings conforms to the requirements of ASME NQA-1-1983 as endorsed in Regulatory Guide 1.28. Safety related coatings meet the pertinent provisions of 10CFR Part 50 Appendix B to 10CFR Part 50. The service level classification of coatings is consistent with the positions given in Revision 1 of Regulatory Guide 1.54, "Service Level I, II, and III Protective Coatings Applied to Nuclear Power Plants." Service Level I and Service Level III coatings used in the AP1000 are tested for radiation tolerance and for performance under design basis accident conditions. Where decontaminability is desired, the coatings are evaluated for decontaminability. The coating applicator submits and follows acceptable procedures to control surface preparation, application of coatings and inspection of coatings. The painters are qualified and certified, and the inspectors are qualified and certified.

The inorganic zinc coating used on the inside surface (Service Level I coatings) and outside surface (Service Level III coatings) of the containment shell is inspected using a non-destructive dry film thickness test and a MEK rub test. These inspections are performed after the initial application and after recoating. Long term surveillance of the coating is provided by visual inspections performed during refueling outages. Other inspections are not required.

The procurement, application, and monitoring of Service Level I and Service Level III coatings are controlled by a program described in subsection 6.1.3.2.

Refer to Table 6.1-2 for identification of Service Level I and Service Level III coating applications in the AP1000.

Service Level II Coatings

The use of Service Level II coatings inside containment is based on the use of selected types of coatings and the properties of the coatings. To preclude the use of inappropriate coatings, the procurement of Service Level II coatings used inside containment is considered a safety-related activity whereas the Service Level II coatings used outside the containment are nonsafety-related.

Appendix B to 10 CFR Part 50 applies to procurement of Service Level II coatings used inside containment on internal structures, including walls, floor slabs, structural steel, and the polar crane, except for such surfaces located inside the chemical and volume control system room # 11209. Service Level II coatings used in the chemical and volume control system room are not subject to procurement under 10 CFR 50, Appendix B, because the room is connected to the containment in a limited way through a drain line. Service Level II coatings used on manufactured components are not subject to procurement under 10 CFR 50, Appendix B, because their high density limits the transport with the low water velocity in the AP1000 containment. In addition, the drain line is routed to the waste liquid processing system sump which is located well below and separate from the recirculation screens. The specified Service Level II coatings used inside containment are tested for radiation tolerance and for performance under design basis accident conditions. Where decontaminability is desired, the coatings are evaluated for decontaminability.

The Service Level II coatings used inside containment are as shown in Table 6.1-2. The application, inspection, and monitoring of Service Level II coatings are controlled by a program described in subsection 6.1.3.2. This program is not subject to 10 CFR 50, Appendix B, quality assurance requirements.

Due to the use of modularized construction, a significant portion of the containment coatings are shop applied to the containment vessel and to piping, structural and equipment modules. This application of coatings under controlled shop conditions provides additional confidence that the coatings will perform as designed and as expected.

The coatings used in radiologically controlled areas outside containment are tested for radiation resistance and evaluated for decontaminability; they are not specified to be design basis accident tested, and they are not procured to Appendix B to 10 CFR 50. Where practical, the same coating materials are used in radiologically controlled areas outside containment as are used inside containment. This provides a high level of quality and optimizes maintenance painting over the life of the plant.

6.1.2.2 Other Organic Materials

A listing of other organic materials in the containment is developed based on the specific type of equipment and the supplier selected to provide it. Materials are evaluated for potential interaction with engineered safety features to provide confidence that the performance of the engineered safety features is not unacceptably affected.

6.1.3 Combined License Information Items

6.1.3.1 Procedure Review

The Combined License applicants referencing the AP1000 will address review of vendor fabrication and welding procedures or other quality assurance methods to judge conformance of austenitic stainless steels with Regulatory Guides 1.31 and 1.44.

6.1.3.2 Coating Program

The Combined License applicants referencing the AP1000 will provide programs to control procurement, application, inspection, and monitoring of Service Level I, Service Level II, and Service Level III coatings. The programs for the control of the use of these coatings will be consistent with subsection 6.1.2.1.6.

6.1.4 References

1. NUREG-0797, "Safety Evaluation Report related to the operation of Comanche Peak Steam Electric Station, Units 1 and 2."

2. Bolt, R. O. and J. G. Carroll, "Radiation Effects on Organic Materials," Academic Press, New York, 1963, Chapter 12.

3. Parkinson, W. W. and O. Sisman, "The Use of Plastics and Elastomers in Nuclear Radiation," Nuclear Engineering and Design 17 (1971), pp 247-280, North-Holland Publishing Co., Amsterdam.

Table 6.1-1

ENGINEERED SAFETY FEATURES PRESSURE-RETAINING MATERIALS

Component	Materials
Core makeup tank	Refer to subsection 5.2.3
Passive residual heat removal heat exchanger	Refer to subsection 5.3.4, Table 5.2-1
In-containment refueling water storage tank	ASTM A240 S32101 or TP304
Passive containment cooling system (safety-related portion)	
Passive containment cooling system water storage tank	ASTM A240 TP304
Valves	SA-182 TP304L
Piping	SA-312 TP304L
Fittings	SA-182 TP304L
PCS Recirculation Subsystem	
Valves	SA-217 Grade WC6
Piping	SA-335 Grade P11
Fittings	SA-234 Grade WP11
Spargers	
Piping	SA-358 TP304 or TP316 or SA-312 TP304 or TP316
Fittings	SA-182 TP304 or SA-403 WP304 or WP316
Containment vessel and penetrations	Refer to subsection 3.8.2.1
Valves in contact with borated water	Refer to subsection 5.2.3, Table 5.2-1
Main control room emergency habitability system	
Valves	SA-182 Grade F11
Pipe	SA-335 Grade P11
Air storage tanks	SA-372

Table 6.1-2 (Sheet 1 of 2)

AP1000 COATED SURFACES, CONTAINMENT SHELL AND SURFACES INSIDE CONTAINMENT

Surface	Boundary	Surface Material	Coating	Coating Functions/Safety Classifications		Coating Classification (1)
Containment Shell, Outside Surface	Shell surfaces above elevation 135′ 3″	Carbon Steel	Inorganic Zinc Coating	1 Promote wettability 2 Heat conduction 3 Nondetachable 4 Inhibit corrosion	1 Safety 2 Safety 3 Safety 4 Safety	Safety – Service Level III
Containment Shell, Inside Surface	Shell surfaces above 7 feet above operating deck	Carbon Steel	Inorganic Zinc Coating	1 Promote wettability 2 Heat conduction 3 Nondetachable 4 Inhibit corrosion	1 Safety (2) 2 Safety 3 Safety 4 Safety	Safety – Service Level I
	Shell surfaces below 7 feet above operating deck	Carbon Steel	Inorganic Zinc Coating with Epoxy Top Coat	1 Nondetachable 2 Inhibit corrosion 3 Enhance radioactive decontamination	1 Safety 2 Safety 3 Safety	Safety – Service Level I
Components Inside Containment	(6)	Material of Component (6)	NA (6)	1 Ensure settling 2 Inhibit corrosion	1 Safety (7) 2 Non-safety	Non-safety (7) Service Level II
Inside Containment	Areas surrounding the containment recirculation screens (3)	NA	NA	NA	NA	NA
	Concrete walls, ceilings and floors (4)	Concrete	Self-Priming High Solid Epoxy	1 Ensure settling 2 Prevent dusting 3 Protect from chemical attack 4 Enhance radioactive decontamination 5 Heat conduction	1 Safety (5) 2 Nonsafety 3 Nonsafety 4 Nonsafety 5 Safety (5)	Nonsafety (5) Service Level II

Table 6.1-2 (Sheet 2 of 2)

AP1000 COATED SURFACES, CONTAINMENT SHELL AND SURFACES INSIDE CONTAINMENT

Surface	Boundary	Surface Material	Coating	Coating Functions/Safety Classifications		Coating Classification (1)
	Steel walls, ceilings, floors, columns, beams, braces, plates (4)	Carbon Steel	Self-Priming High Solid Epoxy	1 Ensure settling 2 Inhibit corrosion 3 Enhance radioactive decontamination 4 Heat conduction	1 Safety (5) 2 Nonsafety 3 Nonsafety 4 Safety (5)	Nonsafety (5) Service Level II

Notes:
1. The applicability of 10 CFR 50, Appendix B, and other codes and standards to coatings and their application are discussed in DCD subsection 6.1.2.1.6.
2. An inorganic zinc coating on the inside of the containment shell is not required to promote wettability, however it has been included in PCS testing and analysis and as a result is considered safety-related.
3. Areas around PXS recirculation screens do not require coatings as defined in DCD subsection 6.3.2.2.7.3.
4. 10 CFR 50, Appendix B, does not apply to DBA testing and manufacture of coatings in the CVS room inside containment as discussed in DCD subsection 6.1.2.1.6.
5. 10 CFR 50, Appendix B, applies to DBA testing and manufacture of these Service Level II coatings as discussed in DCD subsection 6.1.2.1.6.
6. The explicit coating material is not required to be specified. However, the coating material must comply with the restrictions set forth in subsection 6.1.2.1.5 and Table 6.1-2 for components located below the maximum flood level for a design basis LOCA or where there is sufficient water flow to transport debris. If a coating on walls, structures, or components has a dry film density less than 100 lb/ft^3, then testing and/or analysis must be performed to demonstrate that the debris is not transported to an AP1000 screen or into the core through a flooded break. The testing and/or analysis must be approved by the NRC. Inorganic zinc should be used only on surfaces that may be exposed to temperatures that are above the limits of epoxy coatings during normal operating conditions; inorganic zinc coatings used in such applications are required to be Safety – Service Level I to prevent detachment during a LOCA since such debris is not likely to settle out.
7. 10 CFR 50, Appendix B does not apply to DBA testing and manufacture of coatings used on manufactured components as discussed in subsection 6.1.2.1.6.